PEEX Online Meeting (hosted by the PEEX HQ, Helsinki) took place on 28\textsuperscript{th} April 2021 with more than 80 participants.

In this document:
• Author’s 1 pg summaries
1 page highlights from authors
• Urban climate is a key component of:
  • Sustainability and resilience
  • Environmental quality and air pollution
  • Geotechnical risk management

• Urban heat island is:
  • Accessible for monitoring, including satellite remote sensing
  • Robustly relating with social, environmental and economical indicators of settlements
  • Impact biological (green), hydrological (blue), and cryospheric (white) components of the environment
  • Allows to study the climate change processes in anthropic biomes at relevant time and special scales

• Small-scale climate processes raise fundamental questions about the Earth Climate System:
  • How does turbulence dynamics impact the climate and climate change?
  • How do climate anomalies localize? How large could be diversity of local climates and ecological refugia?
  • How do planetary boundary layer properties evolve in cold climate?
Permafrost thawing studies using a manual contact method, carried out on the special site, organized according to CALM standards, showed significant variety of soil active layer thicknesses in the relatively small area (100 m²), indicates significant spatial variability of microrelief, structure and thermophysical properties of soil, as well as vegetation, typical for Arctic desert.

Investigations of active soil layer, started in 2016 after installation on the meteorological site sensors of Finnish Meteorological Institute: thermo-chain with IKES PT00 temperature sensors at depths of 20, 40, 60, 80 and 100 cm, soil heat flux sensor HFP, and two ThetaProbe type ML3 soil moisture sensors, revealed annual cycles of soil temperature with amplitudes up to 15°C less than the amplitudes of surface air layer temperature (Ta) and especially the temperature of the soil upper surface (Tsrad), which in great degree determined by short-wave radiation heating and long-wave radiation cooling. Approximation by linear fittings shows average rates of increase Ta - 0.4°C/year, Tsrad - 0.3°C/year, and temperatures of active soil layer - 0.2°C/year during 2016 - 2020.

Comparison in temperatures of surface and characteristics of surface heat balance during period under study showed that in 2020 the temperature of soil surface at the end of May for a short time reached the temperature of snow melting. It happened 25 days earlier than in other years and led to radical decrease of surface albedo, sharp increase of heat flux to the underlying surface, and increased duration of active soil layer heating. As result the depth of thawing increased up to 1.2 m.

Calculations, executed with the model of seasonal thawing of the upper permafrost, showed the increase of soil active layer thickness beginning from 80-th years of XX Century. However, due to indefiniteness of univocal reaction of vegetation to climate changes the conclusion about fast degradation of permafrost at the present time seems to be anticipatory.

Model of soil active layer growth during summer showed the high sensitivity of model results to description of thermal and physical properties of vegetation and parametrizations of soil thermal and mass-transfer characteristics.

Based on the presented results the main attention in future investigations must be directed to study of spatial inhomogeneity of permafrost (including spatial-temporal distribution of soil surface temperature by IR surveys with quadcopter and distributed network of thermo-chains) and studies of physical properties of vegetation and soil thermal and mass-transfer characteristics.

From Alexander Makshtas, Thermal regime of soil active layer at the Bolshevik Island (Archipelago Severnaya Zemlya) during 2016 – 2020 years
Highlighting Research Questions and Perspectives of PEEX Collaboration

Concerning the presented study we want to emphasize on the following research questions:

• Seasonal effects of carbon emissions from forest fires and agricultural open burning;

• ‘Mid-to-high’ latitudes transportation of carbon-containing compounds and impact on Arctic ecosystems;

• The changes of carbon removal processes in the atmosphere under current climate change

From: Mykhailo Savenets (UHMI, UA)
The impact of wildfires in Ukraine on carbon flux and air quality changes by carbon-containing compounds
Questions

1. Can forest ecosystems regulate their own temperature, and within what limits?

2. Could the melting of permafrost accelerate the rise of land surface temperature? Or in other words, can a positive feedback be formed between these phenomena?

3. Is the rapid rise of the land surface temperature on the islands of the Arctic Ocean after the melting of ice sheets is the result of the preservation by a glacier of the land surface temperature of a colder period?
Research questions and perspectives of PEEX collaboration

1. **Urban environment**
   Developing of state-of-art instrumentation observation system for quantification of urban pollution in a megacity

2. **Arctic**
   What contribution to the Arctic pollution do anthropogenic emissions due to long-range transport from the areas of gas flaring and wildfires? How frequently and high the Arctic atmosphere pollution occurs?

**PEEX Online Meeting**
Wednesday 28th April 2021, 12:30 EEST
12:55 Olga Popovicheva (MSU, RU)
1. Spring-summer 2020 aerosol pollution in Moscow metropolitan area
2. Climate-active aerosol components in the Siberian Arctic, by data from new-developed research aerosol station on island Bely.
Assessment of the impact of potential source regions on environmental pollution in the Arctic regions due to atmospheric transport of mercury

- **Mercury (Hg) long-term measurements:**
  Amderma polar station

- **Research Tools:**
  1. **trajectory modeling approach** (NOAA HYSPLIT) to calculate backward trajectories and cluster analysis to assess dominating directions of mercury atmospheric transport on annual and seasonal scales;
  2. **online integrated approach** (Enviro-HIRLAM) for meteorology–atmospheric composition modelling to simulate atmospheric transport, dispersion and deposition of pollutants for:
     - (a) periods of intense Icelandic volcanic activity (including mercury emissions)
     - (b) short-term episodes of black carbon elevated emissions
  in order to assess potential impact on environment and population of Arctic regions.

From: Fidel Pankratov
Expert capacity in maintaining mercury analysis at polar station Amderma
Modernization of Doctoral Education in Science and Improvement of Teaching Methodologies
Katja Anniina Lauri et al., INAR, University of Helsinki

- Erasmus+ (Capacity Building in Higher Education), coordinated by University of Latvia (Inga Škendere)
- 4 European partners (Finland, Latvia, Poland, UK), 10 partners in Armenia, Belarus & Russia
- 14 courses designed for PhD students, teachers, administrative staff, three strands:
  - A – Research
  - B – Teaching and Learning
  - C – Communication and Cooperation
- Next step: starting Doctoral Training Centres in Russia, Belarus and Armenia

www.emodest.eu
1. Data exchange. How should it work?
2. Funding – applications to EU? Special joint RU/EU calls?
3. Equipment and infrastructure upgrades within PEEX?

Alexey Panov
1. The time series of the SIMBA ET and HT allow identification of moving air-snow, snow-ice and ice-water interfaces.

2. Despite of the air temperature increase, the total maximum ice thickness in the lake has an increasing trend. The increase of maximum ice thickness is due to the increase of granular ice. The interannual variability of maximum granular ice thickness is large ranging from 15 to 80% of the total maximum ice thickness.

3. The relationship between the snow-ice thickness and the phase of the Pacific Decadal Oscillation was on the agenda to be studied.

Yubing Cheng
Investigate the response of cryosphere components, in particular the Arctic lake snow and ice, on the climate change.

- **SIMBA in situ** observation program in lake Orajärvi (2009 - );
- Improving the SIMBA data algorithm;
- **Study:** lake ice surface heat balance;
  - the role of snow on lake ice mass balance;
  - improve the parameterization of snow to ice transformation in snow and sea ice models;
  - discovered snow and ice processes can be improved in climate models;
- **Remote sensing application**
  The SIMBA data set is potentially highly relevant for the development of land applications for planned and existing passive microwave satellite sensors, such as the Copernicus Imaging Microwave Radiometer (CIMR), new Metop multichannel radiometer sensors of EUMETSAT, ESA SMOS, NASA SMAP and Chinese sensors. Due to the inherent coarse resolution of these sensors (tens of kilometers), a key issue is to acquire combined simultaneous data representing various processes in lakes, in addition to surrounding land areas. As such, the SIMBA forms an integral part of the FMI sensor network in Sodankylä.
The purpose of the present work:

• The investigation of the Space Weather characteristics for the appearance moments of very long-live (>10 days) Pressure Systems (LPS) on different terrestrial latitude locations (Saint-Petersburg (59°57'N, 30°19'E); Tambov (52°43'N, 41°27'E)).
• The study of LPS relation to the long periods (LP) of different macrosynoptic processes movements in North Atlantic and Eurasia extratropical latitudes. The types of these processes, as it is known, were defined by A. F. Vangengeim as atmosphere circulation types: E-type (east transport in the troposphere which matches with stable anticyclone above the continent), W-type (west transport), and C-type (meridional transport).

Space Weather factors those were included to investigation:
1. Variations of Solar Activity (SA) parameters
   • 1) daily indices of SA global variations (the full radio flux on \( \lambda = 10.7 \) sm, Wolf-number, the daily sum of the area of all observed sunspots, the number of the new Active Regions);
   • 2) daily characteristics of the SA flare-component in various bands of electromagnetic spectrum (optical-, radio-, X-Ray-band);
   The data source: https://www.swpc.noaa.gov/
2. Variations of Interplanetary Space characteristics in Earth Vicinity (\( e^-, p^+\), \( \alpha \)-particle fluxes);
3. Geomagnetic Field variations (the total magnetic field on the satellite orbit, K-indices on high terrestrial latitudes, K-indices on middle terrestrial latitudes).
   The data source: https://satdat.ngdc.noaa.gov/sem/goes/data/davg/

Terrestrial Ionosphere phenomena those were included to investigation:
• Sudden Ionosphere Disturbances
   The data source: https://www.ngdc.noaa.gov/stp/space-weather/geomagnetic-data/sids/reports/

The results of study:
1. The modes of LP-circulation distributions are in the SA maximum and on the SA rise branch (37% and 36% of all LP cases respectively).
2. Most frequent LP-E-type placed on the SA rise branch (24% of all LP).
3. LP-E-type occurs 56% of all LP.
4. LPs in different terrestrial places occur in different phases of Solar Activity.
5. Different terrestrial places have different LP-features: Saint-Petersburg - LPs of cycloonic activity is more often and prefers the maximum of SA cycle; LPs of different types occur in the minimum of SA cycle. Tambov - the numbers of cycloonic and anticyclic LPS are close to each other; the different pressure systems occur the rise branch of SA cycle.
6. The opening and the final moments of LP-circulations was not the same for those moments of LPs on different terrestrial latitude locations but 50% of Saint-Petersburg LPS and 81% of Tambov LPSs were intersecting with the time intervals of LP-circulations.
Social consequences of climate change in the Arctic towns

Research tasks:
- To identify the public perception of climate change, and compare these with meteorological observation;
- To find social consequences of climate change in Arctic towns;
- To use these findings for adaptation strategies development

Main findings:
1. Good correspondence between the public perception of climate change and objective meteorological data. It is possible to involve public in data collection and adaptation measures development (public participatory tools; citizen science tools);
2. Negative social changes are associated with pollution, landscapes disturbance. Nature protection, rehabilitation of damaged lands and Green deals is supported by citizens.
Subpollen particles are a relatively new subset of atmospheric aerosol particles. It was documented that the fresh pollen grains can rupture at high humidity and during precipitation events. When pollen grains rupture, they release cytoplastic fragments known as subpollen particles (SPP) ranged from several nanometers to about one μm. This talk presents the results of a comprehensive study of chemical analysis, hygroscopic and cloud condensation nuclei properties of subpollen particles in the water saturation ratio from 0.02 to 1.012. We found that SPP, containing a broad spectrum of biopolymers and hydrocarbons, exhibit abnormally high water uptake. This effect may influence the life cycle of SPP and the related direct and indirect impact on radiation budget as well as reinforce their allergic potential.
PEEX perspectives

- This research addresses the fact that the evolution of sea-ice volume is a major uncertainty of the Earth system.
- It develops a new and comprehensive dataset of Arctic sea-ice volume by utilising appropriate sea-ice products, such as ocean reanalyses (a Marine PEEX objective).
- Its results help in determining relevant processes affecting the Arctic sea ice and in understanding changes of the Arctic Ocean during the previous three decades.

From: Petteri Uotila
Validation of the capability of WRF-Chem model and CAMS to simulate near surface atmospheric CO\(_2\) mixing ratio for the territory of Saint-Petersburg

Nerobelov Georgy, Yu. Timofeyev, S. Smyshlyaev, S. Foka, I. Mammarella, Ya. Virolainen

I. Why the monitoring of CO\(_2\) urban emissions is important today?

1. CO\(_2\) influences the radiation balance of the Earth leading to an increase in air temperature;
2. Atmospheric CO\(_2\) content keeps rising due to man-made activity;
3. Megacities have essentially determined (\(\sim 70\%\)) of the anthropogenic CO\(_2\) emissions in the last few decades.

II. How can we estimate CO\(_2\) urban emissions?

1. GHGs Inventories (Bottom-up) - inaccuracies can reach 50% and more!
2. Inverse modelling (Top-down) = Observation data + Modelling of CO\(_2\) transport in the atmosphere
   Validation is required since influences emission estimation significantly

III. Validation of modelled data of near-surface CO\(_2\) mixing ratio

CAMS – reanalysis and analysis

IV. Can we use WRF-Chem and CAMS data to estimate CO\(_2\) emissions from Saint-Petersburg?

1. CAMS reanalysis data can be used in inverse modelling of CO\(_2\) anthropogenic emissions on the scales larger than Saint-Petersburg territory
2. To investigate whether the WRF-Chem model is suitable for the inverse modelling of the CO\(_2\) anthropogenic emissions from the territory of Saint Petersburg, the analysis of modelled CO\(_2\) total column is needed.
Natalia Chubarova, Moscow State University:

Question:
what are the consequences of the significant reduction in urban emissions for radiative and meteorological properties of the atmosphere and for climate in the context of future development of large megacities?

The answer may be found in the analysis of the natural experiment during the COVID-19 pandemic in spring 2020 lockdown conditions. The modelling of these specific lockdown conditions and its verification against measurements may clarify the future development of the urban world.

FUTURE PLANS:

COSMO-Art / Enviro-HIRLAM - model intercomparison for Moscow typical and lockdown conditions with additional contribution from
Alexander Mahura (UHEL-INAR, Finland) and Mikhail Varentsov (MSU, Russia)

(I). Selected periods of interest/ study: March-May, 2018-2020,

(II) Planned experiments with high resolution modelling, aerosols' direct/ indirect effects, and urbanization included,

(III) Different Emission Scenarios (for transport, industry, combustion, non-industrial),

(IV) Comparisons with Observations (meteorology and atmospheric composition).
To better understand the atmosphere surface exchange mechanisms, improve models, and to diagnose climate variability in the Northern Eurasia, accurate measurements are required of all components of the surface energy budget (SEB) and the carbon dioxide cycle over different type of surfaces (for differ ecosystems) and over multiple years.

Knowing which flux components are the major contributors to the observed changes allows us to attribute the changes to specific physical processes, and possibly determine the role, if any, of anthropogenic effects. Once the fundamental processes are quantified and understood, we can evaluate current model performance and improve key parameterizations needed to predict future climate change.

The SEB depends on the temperature and structural characteristics of the surface. Ground measurements have shown that the variations of temperature and humidity across the subsurface layer can be very large. Typical examples of northern ecosystems are tundra, taiga, peatlands, lake ecosystems. To adequately represent them in models of the Earth system, complex long-term measurements of the structure of the atmospheric boundary layer and underlying surface in each of these zones are required. It is necessary to create data sets separately for each ecosystem.
Arctic summers have become warmer and drier, T anomaly June 2020

MODIS data suggests higher number of fires occurring at the Arctic Siberia in years 2012 to 2020 compared to previous 9-year period from 2003 to 2011.
Highlights
Establishing a PEEX Data Hub to make accessible open data in Russia (to non-Russian speakers)!

How can we ensure collected data reaches a larger user base?
Include the steps to create metadata and think of data interoperability to Early Career Sci training.
Projections of regional climate change in Ukraine based on multimodel ensembles of Euro-CORDEX

Svitlana Krakovska, Vira Balabukh, Anastasia Chyhareva, Larysa Pysarenko, Iryna Trofimova, and Tetiana Shpytal
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine (krasvi@ua.fm, SvitlanaKrakovska@gmail.com)

The study has been done within the project ‘Assessing Climate Change Impacts, Opportunities and Priorities for Ukraine’ with the support and coordination of the World Bank in order to help the Government of Ukraine assess and understand the impacts of climate change on key sectors to make informed decisions on adaptation policies and programs.

Periods:
1961-1990 – Past
1991-2010 – Base (0 – E-Obs)
2021-2040 – Near future (I)
2041-2060 – Middle of century (II)
2081-2100 – Far future (III)

Approach: to assess changes in mean climatic characteristics and indices (>100)

Extremes events need more detailed consideration and were not assessed in this study.

PEEX Online Meeting, 28th April 2021
General Conclusions

• Special attention has to be put on the environmental changes happening in Arctic due to the temperature rise

• Satellites provide lots of data which allow following those changes

• We should think how to better utilize available satellite data, in combination with ground-based and modelled data